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pearance of the operculum of a dry capsule from which the spores are escaping. The loosely twisted mesh of the narrow teeth forms a perfect sieve to control the escape of the spores. If you place a peristome in this condition under the microscope without mounting medium or cover glass and breathe upon it the teeth will straighten perceptibly. If you dip it in warm water it will assume the original position shown in Fig. 7, if it be comparatively fresh; if it be rather old and somewhat broken it may look like Fig. 6. The perfect cone in Fig. 7 is of course a waterproof covering for the spores inside.

In a succeeding paper the structure and development of the peristome of *Barbula* will be taken up.

FISSIDENS GRANDIFRONS, ITS HABITS AND PROPAGATION.

BY E. J. HILL.

In July, 1901, *Fissidens grandifrons* Brid., was obtained from the face of a cliff along the Illinois River, near Utica, Ill. It forms part of the ledge famed in Indian legend as "Starved Rock." The bed of moss was kept wet by water oozing from the rock. The stems were uncommonly short, 1.5-4 cm., the average but 2 or 3 cm. long. The leaves were about $3 \times .4$ -.5 mm., or about the size of those in specimens from Boyne Falls, Mich. They are smaller than those of robust plants from a creek near Bear Lake, Manistee Co., Mich. (1880), which are $4 \times .6$ -.7 mm. These plants were as usual without fruit, but a careful search disclosed a couple of female flowers, one of which is shown (Fig. 1.). There were 10 or 12 archegonia, .6-.8 mm. long. Authorities generally give them as numerous, 30-60 by some. No paraphyses were seen. The perichætil leaves taper rather abruptly from a broadly oval base to a point of variable length, the point in the longer ones similar to the vertical lamina of an ordinary leaf, but relatively narrower. Flowers in *F. grandifrons* are rare. Schimper mentions them as occurring on specimens from Niagara Falls; Boulay, as noticed by Spruce and one or two others on plants from the region of the Pyrenees Mts.; Limpricht, for the territory embraced by his Mossflora, Germany, Austria, and Switzerland, gives only male flowers as occurring. The fruit, as already stated by Mrs. Britton in THE BRYOLOGIST for July, 1900, has been found but once, in plants from the N. W. Himalayas.

The plants make compensation for this by asexual propagation. Those from "Starved Rock" produce axillary buds which grow into rooting shoots. They are found in all stages of development from those just beginning, to shoots with several pairs of leaves (Fig. 3-6). The rhizoids start when the buds are very small and the leaves scale-like, as short blunt brown processes. They spring from the edges and base of the leaves as well as from the base of the bud-stem and lengthen as the shoot grows. In all cases observed these shoots take the place of branches and ultimately become a rooting branch. Owing to the conditions under which the plants were growing on the cliff, they do not generally become detached but strike root and remain in place, forming new stems to replace the old ones, which are brown

and decaying at the base. The stems lie close on one another and are freely provided with tufts of rhizoids along the under surface. The leaves also form rhizoids from the base of the costa, as shown in Fig. 2. The bed of moss was dirty, being well filled with sand from the disintegrating rock and inwashing by rains of finer material from the soil above. The shoots are thus furnished with a soil in which to root without a change of place, but as their hold on the parent stem is slight, when grown to the size shown in Figs. 5 and 6, they easily become detached and in running water would serve for much wider distribution. This is shown in specimens from Boyne River, on which minute shoots with basal rhizoids are seen. Some of them show but slight adhesion to the stems when but 2 or 3 mm. high. The tufted rhizoids, though present in other places, are more abundant at the base of branches and the beginning of new or annual growths. At points where such growths start the stems are most readily broken, and would most likely divide.

The asexual propagation of *F. grandifrons* does not appear to have been recorded. That of all the Fissidentaceæ, at least through the medium of brood-organs, is stated by Correns* to be either rare or as yet unobserved; probably the latter. He cites the case of *F. (Conomitrium) Metzgeria* (C. Müll.) Par., a semiaquatic species of the eastern Soudan, whose leaves when old bear little tufts of rhizoids on their point and other parts, out of which,



Description of figures of *Fissidens grandifrons* each $\times 13$. 1. Female flowers. 2. Leaf with basal rhizoids. 3. Very young bud. 4. Bud more advanced. 5. Branch shoot with short axis. 6. Branch shoot ready to be detached.

*Vermehrung der Laubmoose durch Brutorgane und Stecklinge, p. 54.

Müller thought, plants could probably spring. The cases given by Correns where bits of stems, leaves, and brood-bodies form a protonema, are chiefly concerned with plants under cultivation. *F. bryoides* (L.) Hedw. was shown to produce resting branch-primordia (Astanlagen), which he regards as greatly reduced leaves, consisting of a modified costa, and are called brood-leaves. An example familiar to moss-students is that of the brood-bodies on the pseudopodia of *Aulacomnium palustre*. *F. grandifrons* doubtless partakes of this property, as seen in its ability to form rhizoids on the costa (Fig. 2). As Fig. 4 shows them springing from the leaf-margin, it also partakes of the leaf characters of *F. Metzgeria* as seen by Müller. Heald*, experimenting with *F. bryoides*, found buds borne in the region of the leaf-axils, "which in course of time were detached from the stems." This is more like the incipient form of the buds in *F. grandifrons*, though no protonema may anywhere intervene in the latter. The case of *F. taxifolius* (L.) Hedw., where the brood-bodies are root-bulbils formed of rhizoids and are borne on the stems, does not show its analogue in my specimens of *F. grandifrons*. The striking case observed by Schimper and by Goebel, in which *P. (Conomitrium) julianus* (Sav.) Schimp. bore shoots on the calyptra, may be given in this connection for completeness. Those cultivated by Schimper bore them on the outer surface without the previous formation of a protonema; those observed by Goebel† sprang from the inner surface "with the intervention of a short piece of protonema." But the case of this species multiplying by leafy branches, which become detached from the stem, as noticed by Schimper and mentioned by Goebel (p. 147), is like that of *F. grandifrons*. Here branches are isolated by decay at their base, and break off from the stems to form new plants.‡ Correns, in an enumeration of mosses possessing brood-organs in the region of Limpricht's flora, mentions this (as *Ocotodoceras julianum*) as one having brood-branches.

The substratum on which I have found *F. grandifrons* differs from those usually given. Nearly all authorities mention limestone. Mrs. Britton says, "in water saturated with lime, or in mud." At "Starved Rock" it was on sandstone. This is the outcropping rock, but it overlies the calciferous formation which comes to the surface not far below in the river valley. But the presence of lime carbonate in the water passing through the bed is shown by quite a thick incrustation on some of the older stems and leaves. The moss in both stations in Michigan was attached to sticks and logs, and the stems mostly immersed. The specimens from Boyne River indicate the presence of lime on the older parts of the stems, chiefly as a thin plate in the fold made by the upward conduplication of the leaves. Those from Barr Creek, Bear Lake, are very clean and quite free from all foreign matter. A slight effervescence from some most favorable bits of stems placed in acid showed the presence of lime. These streams are usually the outlets of little lakes and ponds whose bottoms are often whitened by decaying molluscan shells.

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*Botanical Gazette, 26: 200, 1898.

†Synopsis Mus. Eurp. p. 123. ‡Outlines of classification, etc. p. 174.

§Goebel in Schenk's Handbuch der Botanik, 2: 389.